



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

SUBJECT: Existing Chemical Exposure Limit (ECEL) for Occupational Use of
1-Bromopropane (1-BP)

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EPA has developed an 8-hour existing chemical exposure limit (ECEL) in support of risk management efforts on 1-Bromopropane (1-BP) under TSCA section 6(a), 15 U.S.C. §2605. EPA calculated the ECEL to be 0.05 parts per million (ppm) (0.25 mg/m³) for inhalation exposures to 1-Bromopropane (1-BP) as an 8-hour time-weighted average (TWA) and for use in workplace settings (see Appendix A) based on the chronic cancer inhalation unit risk (IUR) at a risk level of 1X10⁻⁴. EPA has determined, as a matter of risk management policy, that ensuring exposures remain at or below the ECEL will eliminate the unreasonable risk of injury to health resulting from inhalation exposures in an occupational setting for those conditions of use identified as presenting unreasonable risk in the Risk Evaluation for 1-Bromopropane (1-BP) (U.S. EPA, 2020) under TSCA.

EPA expects that, at the cancer ECEL of 0.05 ppm, a worker or occupational non-user is protected against developmental effects resulting from acute or chronic occupational exposure, if ambient exposures are kept below this ECEL.

The Occupational Safety and Health Administration (OSHA) has not established exposure limits for 1-Bromopropane (1-BP). The American Conference of Governmental Industrial Hygienists revised the threshold limit value (TLV) for 1-bromopropane from 10 ppm to 0.1 ppm in 2014 <https://files.nc.gov/ncdol/documents/files/IG-52-Bromopropane.pdf>. However, the TLVs are guidelines and not enforceable regulatory standards. EPA's ECEL is meant to be a legally enforceable exposure limit.

Published NIOSH/OSHA/EPA methods were identified and the ECEL is within the limit of detection (LOD) of all of the methods identified in Appendix B.

Appendix A: ECEL and Other Exposure Limit Calculations

This appendix presents the calculations used to estimate the ECEL and other exposure limits used for comparison. The resulting ECEL value was rounded. The values used in the equations are included in the Risk Evaluation for 1-BP (USEPA 2020).

Lifetime Cancer ECEL

The ECEL is the concentration that EPA determined would indicate no unreasonable risk of injury to human health from chronic inhalation exposures in an occupational setting for the endpoints that are the basis for the TSCA unreasonable risk determination. The ECEL_{cancer} is the concentration at which the extra cancer risk is equivalent to the benchmark cancer risk of 1×10^{-4} . The ECEL was calculated for cancer (lung tumors) using the IUR of 4.0×10^{-3} per ppm and based on the 95th percentile of working years (WY, 40 years).

$$ECEL_{cancer} = \frac{Benchmark_{cancer}}{IUR} * \frac{AT_{IUR}}{ED * EF * WY} = \frac{1 \times 10^{-4}}{4.0 \times 10^{-3} \text{ per ppm}} * \frac{8 \frac{h}{d} * \frac{260d}{y} * 78y}{8 \frac{h}{d} * \frac{260d}{y} * 40y} = 0.05 \text{ ppm}$$

$$ECEL \left(\frac{mg}{m^3} \right) = \frac{ECEL \text{ ppm} * MW}{Molar Volume} = \frac{0.05 \text{ ppm} * 122.99 \frac{g}{mol}}{24.45 \frac{L}{mol}} = 0.25 \frac{mg}{m^3}$$

Where:

Molar Volume = 24.45 L/mol, the volume of a mole of gas at 1 atm and 25 °C
 MW = Molecular weight of 1-BP (122.99 g/mole)

Acute Non-Cancer Exposure Limit

The acute occupational exposure limit (EL_{acute}) was calculated as the concentration at which the acute MOE would equal the benchmark MOE for acute occupational exposures using the following equation:

$$EL_{acute} = \frac{HEC_{acute,occupational}}{Benchmark \text{ MOE}_{acute}} * \frac{AT_{PODacute}}{ED} = \frac{17 \text{ ppm}}{100} * \frac{8h}{8h} = 0.17 \text{ ppm} = 0.86 \frac{mg}{m^3}$$

Chronic Non-Cancer Exposure Limit

The chronic occupational exposure limit (EL_{chronic}) can be calculated as the concentration at which the chronic MOE would equal the benchmark MOE for chronic occupational exposures. However, for purposes of risk management, EPA has determined that for effects such as developmental toxicity that are expected to present in both acute and chronic (repeated) exposure contexts, the relevant averaging time should be considered equivalent across both acute and chronic exposure scenarios. Therefore, the resulting EL_{chronic} would be the same as EL_{acute}.

Where:

AT_{PODacute} = Averaging time for the POD/HEC used for evaluating non-cancer, acute occupational risk, based on study conditions and/or any HEC adjustments (8hrs/day) (See footnote 4 to Table 3-8)
 AT_{IUR} = Averaging time for the cancer IUR, based on study conditions and any adjustments (8 hrs/day for 260 days/yr) and averaged over a lifetime (78 yrs) (see Table 3-6 and Section 3.2.8.2.1)).

Benchmark MOE _{acute}	=	Acute non-cancer benchmark margin of exposure, based on the total uncertainty factor (UF) of 100 (see Table 3-2)
Benchmark _{Cancer}	=	Benchmark for excess lifetime cancer risk 1×10^{-4} (see Section 4.2.4.2)
ECEL	=	Existing chemical exposure limit (mg/m ³ or ppm)
EL _{acute}	=	Exposure limit based on acute developmental toxicity
EL _{chronic}	=	Exposure limit based on chronic developmental toxicity
ED	=	Exposure duration (8 hrs/day) (see Section 2.3.1.2)
EF	=	Exposure frequency (260 days/yr), (see Section 2.3.1.2).
HEC _{acute occupational} ,	=	Human equivalent concentration for acute occupational exposure scenarios (see Table 3-2)
IUR	=	Inhalation unit risk (per ppm) (see Table 3-6)
WY	=	Working years per lifetime at the 95 th percentile (40 yrs) (see Appendix B to 1-BP Supplemental File: Supplemental Information on Occupational Exposure Assessment)

Unit conversion:

$$1 \text{ ppm} = 5.03 \text{ mg/m}^3 \text{ (based on molecular weight of 122.99 g/mol for 1-BP and molar volume of 24.45 L/mol at 25}^\circ\text{C and 1 atm pressure)}$$

$$ECEL \left(\frac{\text{mg}}{\text{m}^3} \right) = \frac{ECEL \text{ ppm} * MW}{Molar Volume}$$

References

U.S. Environmental Protection Agency. Risk Evaluation for 1-Bromopropane (1-BP) CASRN: 106-94-5. EPA-740-R1-8013. Office of Chemical Safety and Pollution Prevention. August 2020. Available at: <https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/final-risk-evaluation-1-bromopropane#documents>; Docket Number: EPA-HQ-OPPT-2019-0235.

U.S. Environmental Protection Agency. 2002. A Review of the Reference Dose and Reference Concentration Processes. Final Report. EPA/630/P-02/002F. Prepared for the Risk Assessment Forum. December.

Appendix B: Summary of Air Sampling Analytical Methods Identified

EPA conducted a search to identify relevant NIOSH/OSHA/EPA analytical methods used to monitor for the presence of 1-Bromopropane (1-BP) in air (see Table 1). The sources used for the search included the following:

- 1) NIOSH Manual of Analytical Methods (NMAM); 5th Edition
 - URL: <https://www.cdc.gov/niosh/nmam/default.html>
- 2) NIOSH NMAM 4th Edition
 - URL: <https://www.cdc.gov/niosh/docs/2003-154/default.html>
- 3) OSHA Index of Sampling and Analytical Methods
 - URL: <https://www.osha.gov/dts/sltc/methods/>
- 4) EPA Environmental Test Method and Monitoring Information
 - <https://www.epa.gov/emc/epa-websites-environmental-test-method-and-monitoring-information>

Table 1: Limit of detection (LOD) summary for air sampling analytical methods identified.

Air Sampling Analytical Methods	Year Published	LOD ^a	Notes	Source
NIOSH 1025	2003	0.016 ppm (for a 12 Liter sample)	Specific to 1-BP and 2-BP. LOD is calculated from reported LOD of 1 µg per sample. Lower working range (functional LOQ) is approximated to be 0.049 ppm.	https://www.cdc.gov/niosh/docs/2003-154/pdfs/1025.pdf
OSHA 1017	2013	0.0003 ppm (0.350 ppb)	Specifies GC(ECD) analysis LOQ is approximated to be 0.0012 ppm (1.2 ppb) for a 12 Liter air sample)	https://www.osha.gov/dts/sltc/methods/validated/1017/1017.pdf
OSHA PV2061	1999	0.002 ppm (for a 12 Liter sample)	Can analyze for both 1-BP and 2-BP (GC/FID analysis) LOQ is approximated to Be 0.007 ppm Partially evaluated (PV) method presented for information and trial use	https://www.osha.gov/dts/sltc/methods/partial/pv2061/pv2061.pdf

Air Sampling Analytical Methods	Year Published	LOD^a	Notes	Source
EPA TO-17	1999	≤0.0005 ppm (0.5 ppb)	Not specific to 1-BP Method sometimes sensitive to humidity which can affect accuracy of results at higher sample volumes (greater than 1 Liter) and longer sampling periods (greater than 1 hour).	https://www.epa.gov/sites/production/files/2019-11/documents/to-17r.pdf
ppm = parts per million; ppb = parts per billion				